Information Sheet # 36

B•U•C•K•E•Y•E POWER SALES

Your Reliable Guide for Power Solutions

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

Differences Between 80% and 100% - Rated Circuit Breakers

1.0 Introduction

Circuit breakers (CBs) are designed to carry 100% of their rated current, yet the National Electric Code (NEC) dictates an 80% application.

This information sheet discusses the difference between 80% and 100% rated circuit breakers.

2.0 Circuit Breaker Design

A CB is designed and evaluated to carry 100% of its rated current for an indefinite period of time, under standard test conditions. Underwriters Laboratories (UL) 489 Standard for Safety for Molded-Case CBs (MCCBs) and CB Enclosures include mounting the CB in free air, i.e. without an enclosure, where the ambient temperature is held at 40ºC (approx. 104ºF). Under these conditions, molded-case CBs are required not to trip at rated current.

However, a CB most frequently is applied in equipment at 80% of its rated current under NEC Sec. 384-16 (c).

3.0 CB Characteristic Trip Curves

These curves document how long it takes for specific CBs to trip depending on the level of current. For a typical thermo-magnetic CB, the manufacturer's published curves will indicate the time it takes CB to trip on overload. An overload condition will cause heat build-up around the current path within the CB, as well as along the power conductors. This heat (generated by the current flow) is actually what causes the CB to trip – not simply the magnitude of the current flow. This portion of the curve is said to have an inverse time characteristic, meaning that the CB will trip in less time at higher levels of current flow. (*Diagram one details the thermal and magnetic trip mechanism of a typical C.B*.)

Since both the CB and conductor react to heat, the overall operating temperature of the equipment becomes a factor in sizing a CB in an enclosure. Other factors that may affect this operating temperature include:

- Size and location of the enclosure
- More than one current carrying device, housed in same enclosure
- Level of current that each device is carrying
- Environmental conditions in the area of the equipment

This means that simply designing a CB to hold 100% of its rated current only addresses part of the concern. The equipment must be able to safely sustain the heat generated by all the sources without exceeding the temperature limits in the product test standard. Both of these factors are accounted for by the sizing rules imposed by the NEC.

4.0 1996 NEC.

This recognizes that over-current protection devices (OCPD) are affected by the heat in the system. As such, it defines the concept of continuous loads and the 80% rule in order to try and offset the effects of heat in the system when sizing a CB.

5.0 Continuous Loads

In Article 100, NEC defines a continuous load as "a load where the maximum current is expected to continue for 3 hours or more. It is therefore critical to understand that this is a load at its maximum current, uninterrupted for at least 3 hours. Office lighting typically meets this qualification.

OCPD size = 100% of non-continuous load + 125% of continuous load. Sec. 384-16 (c) has the same requirement except that it is stated in terms of loading of the OCPD. This rule states that an OCPD can be loaded to only 80% of its rating for continuous loads. We should remember that 80% is the inverse of 125% (0.80 = 1 divided by 1.25) and as such, the rules are indeed identical in their end requirement.

Note! *Read the rule carefully - the 125% sizing of the OCPD (or 80% loading) is ONLY applicable when continuous loads are involved. CBs and other OCPDs can be sized at 100% of their rating for any NON-CONTINUOUS load applications.*

(Continued over)

(Continued from previous page)

6.0 100% -Rated Devices

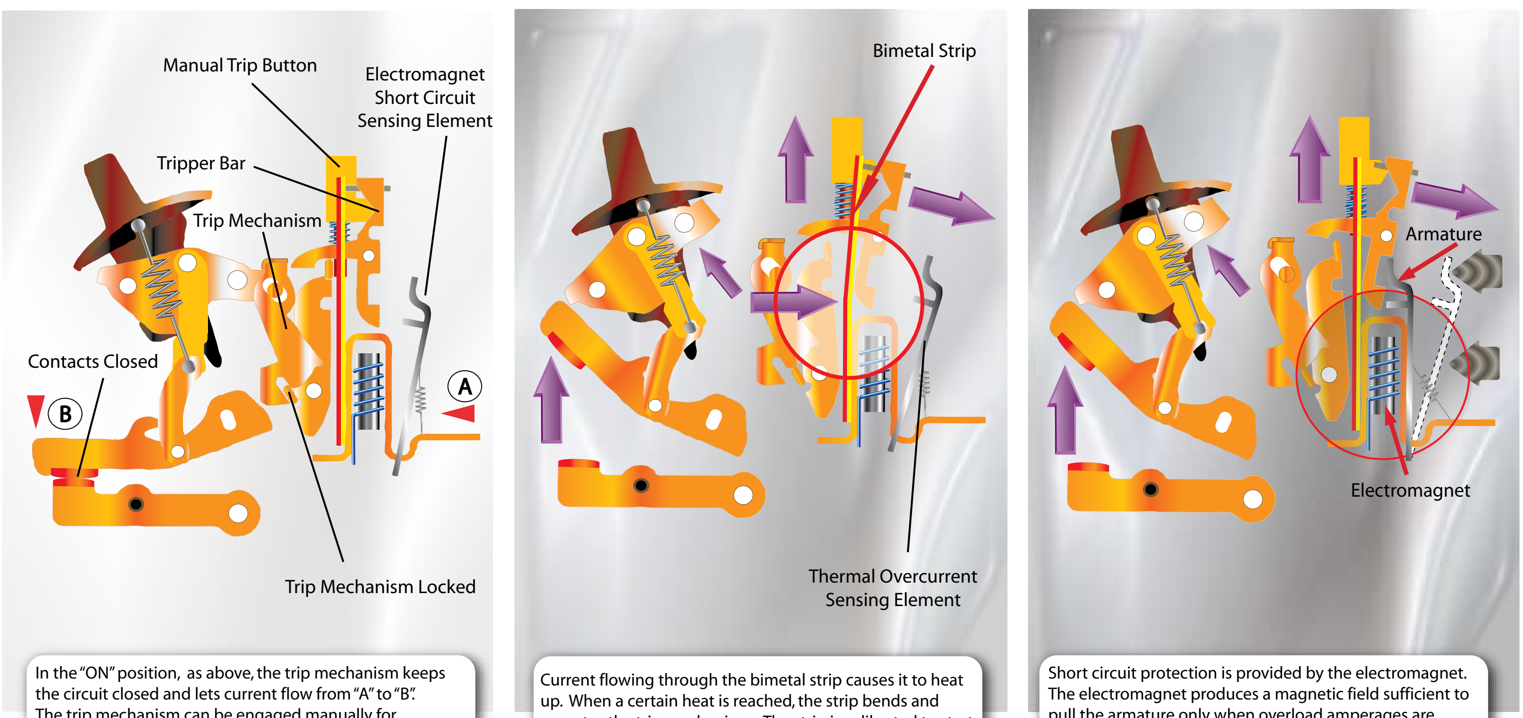
The NEC does not recognize complete assemblies (including OCPDs) that are listed for operation at 100% of their rating for continuous loads. This means that the equipment has undergone additional testing to verify that it can handle the additional heat rise associated with this level of operation. A 100%-rated CB and the end use equipment have been tested to verify that the additional heat generated by the 100% continuous loading conditions, is safely dissipated. Other equipment specifications also are driven by the need to dissipate the heat associated with the level of heat rise achieved during 100%-rated testing. Where the temperature at the CB wiring terminals exceeds 50ºC during 100% rated testing UL 489 requires the use of 90ºC insulated wire (sized at 75ºC ampacity with these CBs, and the CB MUST be marked as such by the manufacturer. UL489 also specifies minimum enclosure size and venting requirements if need for heat dissipation. A CB that has successfully passed these additional test is still not listed for applications at 100% of its rating for continuous loading unless it is marked as such by the manufacturer.

7.0 Summary

A CB either carries a standard rating -80% or a 100% rating. The standard rating is subject to NEC sizing rules. 100%-rated CBs are permitted to be loaded continuously at their full rating as long as the assembly is listed and the conductors are properly connected.

Diagram 1 - Thermal and Magnetic Trip Elements of a Circuit Breaker

Closed Energized Circuit Position | **Tripped Thermal Overload Position** | **Tripped Magnetic Short Circuit**



In the "ON" position, as above, the trip mechanism keeps the circuit closed and lets current flow from "A" to "B". The trip mechanism can be engaged manually for overload by thermal sensing and short circuit by an electromagnetic device. There is also a manual trip button.

Current flowing through the bimetal strip causes it to heat up. When a certain heat is reached, the strip bends and operates the trip mechanism. The strip is calibrated to start bending when overload amperage is reached. The higher the current flow, the quicker the bimetal trips the breaker.

Short circuit protection is provided by the electromagnet. The electromagnet produces a magnetic field sufficient to pull the armature only when overload amperages are reached. Tripping occurs when the armature strikes the trip bar. This cuts current flow and releases the armature.

MEMBER EGSA Electrical Generating Systems Association

Columbus, OH
6850 Commerce Court Drive
P.O. Box 489
Blacklick OH 43004-0489
(614) 861-6000
(800) 523-3587
(614) 861-2291 fax

Cincinnati, OH
7782 Service Center Drive
West Chester, OH 45069
(513) 755-2323
(800) 368-7422
(513) 755-4515 fax

Cleveland, OH
8465 Tower Drive
P.O. Box 394
Twinsburg, OH 44087-0394
(330) 425-9165
(800) 966-2825
(330) 487-0229 fax

Indianapolis, IN
1229 Indy Place
Indianapolis, IN 46214
(317) 271-9661
(800) 632-0339
(317) 271-0242 fax

BPS B·U·C·K·E·Y·E POWER SALES
www.buckeyepowersales.com